AUSTRALIAN SOCIETY FOR LIMNOLOGY

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LIMNOLOGY NEWSLETTER

Volume 24. Number 1. April 1986

The Australian Society for Limnology is an association of over 400 people with professional or amateur interests related to Australian inland waters Since its inception in 1961 the Society has played an important role in fostering limnological work in this country. The ASL promotes liason between limnologists in academic, private and governmental institutions and has a vested interest in the conservation of aquatic and related resources. Annual conferences are held near centres of limnological interest, and the programme includes scientific sessions, field excursions and social activities.

The ASL produces a newsletter with notes on activities, articles of general interest, book reviews and conference announcements; a Bulletin of original scientific papers and occasional Special Publications. A further publication is the Directory of Australian Limnologists.

Membership applications are welcomed; five classes of subscribing membership are available:

Ordinary Members : $15.00
Student Members : $6.00
Life Members : $200.00
Institutional Members : Fees on Application
Sustaining Members : Fees on Application

Membership subscriptions cover the period from 1 July to 30 June and members receive all publications. Members may also choose to receive the Australian Journal of Marine and Freshwater Research, the Australian Journal of Zoology and/or the Australian Journal of Botany at reduced rates. The subscription period for each journal is the calendar year following the year in which the subscription is paid.

ASL Executive 1985-6

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LIMNOLOGY

NEWSLETTER

Volume 24. Number 1. April 1986

Contents

Minutes of the 24th A.G.M. 2

Abstracts of papers presented at the 24th Congress, Jarrahdale, WA 8

In Brief 34

Coming Events 38

Limnology Biliography 41

25th Congress Excursion Offer 44

Minutes of the Australian Society for Limnology
Annual General Meeting held at Jarrahdale,
Western Australia, on 25 August 1985

In the Chair - the President, J. Kirk

1. The meeting commenced at 5.20 pm.

2. Apologies were received from: T. Sharley, I. McKelvie, H. Midgely, B. Hart, P. Suter, J. Powling, P. De Deckker and I. Potter.

3. Minutes of the previous meeting were accepted on the motion of G. Ganf, seconded L. Barmuta.

4. President's Report:

Your Executive has met on six occasions since the last A.G.M. I will not burden you with a detailed account of our deliberations and correspondence and so on, but shall mention a few of the more important matters. One was the Boden Conference on "Stream Ecology in Australia" held in Thredbo in February this year, and organized by Sam Lake and Ian Campbell. They are to be congratulated on organizing a successfull and useful conference on a limnologically important topic.

Another issue which came up during the year was the reduction in Government support for research in the 1984 budget. As President of A.S.L. I wrote to the Prime Minister registering our strong opposition. A more substantial move along these lines however, was the formation in April of this year of a Federation of Australian Scientific and Technological Societies, whose main aim is to seek to raise the level of funding for scientific and technological research in this country. It seems that the original organizers of this association were not aware of the existence of A.S.L., and so we were not invited to their initial deliberations. We have now told them we exist, and we have been invited to attend the next meeting of the Federation on 12 November, at which, we understand, all attending societies will be empowered to vote. The many different societies in the Federation are to be organized into groups and each group will elect one or two representatives to the Council of the Federation which will have a membership of about 30.
Professor Jorg Imberger, President of the Australian Marine Sciences Association, has suggested to the Interim Committee of the Federation that one such group be constituted of aquatically-oriented societies, a suggestion with which your Executive has agreed. Whether this will eventuate remains to be seen.

I think the most important matter with which your Executive has had to deal in its term of office has been the A.S.L. book. You may remember that at last year's A.G.M. it was proposed that, to mark the 25th anniversary next year of the founding of A.S.L., the Society should bring out a book on Australian limnology. This suggestion, put forward by Patrick De Deckker, was enthusiastically endorsed by the meeting, and the incoming Executive was given the responsibility of reaching a decision on the kind of book most appropriate for the purpose. After much deliberation and sounding out of opinion, the conclusion was reached that what was needed was not an actual textbook on Australian limnology - which had been one initial possibility suggested - but a series of forward looking review articles on a set of topics of key importance, which, between them, would provide some idea of how far Australian limnology has got, and where we need to go from here.

Patrick De Deckker and Bill Williams were invited to be the editors of the book. They agreed and without delay set to work inviting prospective authors to contribute chapters, and having discussions with possible publishers. Matters are now well under way, with about 40 papers envisaged, most of them I imagine in by now, and I will shortly invite Bill or Patrick to tell us the current state of preparation of what promises to be a fascinating publication that will mark, in the most fitting and appropriate manner possible, the first quarter century of the Australian Society for Limnology.

To ensure publication within Australia at a reasonable price, it is necessary for A.S.L. to undertake to purchase a certain number of the books. The current proposal is that we take 200 at two-thirds the normal retail price. We will then resell these to members without profit.

A related matter, also to mark our 25th anniversary, is a special limnological issue of the Australian Journal of Marine and Freshwater Research. There has been a certain amount of information on this in the Newsletter already. I will ask Ian Campbell to say a bit more about it shortly.

There is one final point I wish to make as the retiring President, and it is that I think the Society should give serious consideration to building up its financial reserves. In the past, the aim seems to have been to keep the subscription to rock-botton, with, on top of this, especially generous concessions to student members. The consequence of this is that, after 25 years the Society has only a few thousand dollars to its name. The disadvantage of such a situation is that when as important and worthwhile but unexpected initiative come up, which in the first instance will require an input of funds by the Society (and the example I am thinking of here is our

forthcoming limnology book) the society may find itself stretching its reserves to the limit. I hope - and this will, of course, be discussed a little later on - that the members will see their way to increasing the subscription to a level which, without being exhorbitant, will, over a period of years, lead to a healthy improvement in our financial position.

5. Secretary's Report. Most correspondence was of a routine nature and has been dealt with. Items requiring discussion are listed under general business.

6. Treasurer/Membership Officer's Report. G. Ganf moved that the financial statement as tabled be accepted, seconded D. Mitchell and passed. M. Hart reported that membership is currently stable at around 420 members, including institutional and similar members. A.S.L. will continue to arrange for C.S.I.R.O. journals to be available at reduced rates - Aust. J. Zool. $60, Aust. J. Bot. $40, and Aust. J. Mar. Freshwater Res. $35 per annum.

   A plea was made for changes of address to be notified promptly.

7. Auditor's Report - the Auditor's report prepared by I.D. Hiscock was accepted.

8. Editor's Report. I. Campbell reported that five Newsletters had been sent since the previous A.G.M.. The Bulletin will go to press in the next few weeks. C.S.I.R.O. has agreed to publish the A.S.L. book. This required A.S.L. to buy 400 copies at half retail price for resale to A.S.L. members. Negotiations are continuing to reduce this to about 200 copies at two-thirds the price, an outlay by A.S.L. of $6,000. The cost of the book will be about $30 each.

   The special edition of A.J.M.F.R. for A.S.L's 25th year will be out in May 1986. Review papers will be accepted.

   I. Campbell requested that in future a Newsletter editor and a Bulletin editor be appointed.

9. Jolly Award Committee Report:

   I now get to a part of the proceedings - perhaps the only part - that I will actually enjoy. I am happy to be able to tell you that this year there will be a Jolly Award. I remind you that there is nothing automatic about this Award. Although not given more than once a year, it is not necessarily given every year. The Jolly Award Committee is proud to present the Award this year to Dr George Ganf of the Botany Department, University of Adelaide.

In giving our reasons for making the award I do not think I can do better than quote from those two members of the Society who originally nominated him.

"George well meets the criteria of the award, established as a memorial to our pioneering member. With some forty or so publications in a variety of good journals, he is abundantly productive. His African phase established him as a limnologist with an incisive mind. Since coming to Australia he has made his mark in a way which commands respect from his colleagues here and overseas. He has trodden a way different from many Australian limnologists in eschewing the essential task of pathfinding in an unstudied lakeland. Instead he has brought to this land a breadth of experimental, fundamentalist limnology with vigour and flair, and has inspired excellent students in the same vein. His elegant work on the mythology of cladoceran table manners makes the point. If, in modern idiom, 'relevance' to a parched land is sought, Ganf's work lies at the heart of intelligent reservoir management."

To that I would like to add that one thing that particularly distinguishes George Ganf is his versatility as a limnologist. While his central theme has always been primary production, he has been prepared to tackle any aspect of it that seemed necessary to arrive at an understanding of the factors that control it. Thus, in addition to directly studying the process itself, as in his original work in Lake George, Uganda, he has also studied the underwater light climate, nitrogen fixation, the effects of stratification, nutrient availability, parasitism and grazing, culminating in his recent important work with Russell Shiel on feeding behaviour in relation to limb morphology in zooplankton.

I am sure you will all agree with the Committee that George Ganf's contribution, both to limnology as a whole and to Australian limnology in particular, makes him a most worthy recipient of the Jolly Award for 1985.

10. Student Award Committee Report. M. Brock spoke on behalf of the Committee. The prize was awarded this year to L. Barmuta.

11. 25th Congress. This will be held at Lorne in May 1986.

12. 26th Congress. Both Canberra and Albury-Wodonga were suggested. If held at Albury-Wodonga an appropriate theme would be the Murray-Darling River system.

13. 27th Congress. Jabiru was suggested with the theme of tropical limnology. If accommodation in Jabiru was inadequate, Darwin might be an alternative.

14. Election of the Executive: the following were elected unopposed for 1985/1986.

President	I. Campbell (Vic)
Vict President	T. Hillman (NSW)
Secretary	R. Marchant (Vic)
Treasurer/Membership Secretary	M. Hart (Vic)
Executives:	
	P. Breen (NSW)
	C. Yule (Vic)
	J. Davis (wA)
	R. StClair (Vic)
	M. Barson (ACT)
	K. Skinner (NSW)
	M. Harvey (Vic)
	M. Geddes (SA)

15. Election of Auditor - M. Hart nominated I.D. Hiscock; second P. Tyler, and passed.

16. General business

16.1 Federation of Australian Scientific and Technological Societies - possible A.S.L. membership of this lobby organisation was discussed. The suggested membership fee at this stage was $5/head for all member societies. Reservations were felt about joining F.A.S.T.S. due to cost, inadequate representation with the organisation, and inadequate grouping with other societies.

D. Mitchell moved that the incoming Executive nominate a representative to attend the next full meeting of F.A.S.T.S. to obtain the latest information, and (if appropriate) discuss reservations aired above. The Executive should not commit A.S.L. without widespread consultation with members, or a postal vote. Seconded I. Benzie, passed.

A possible alternative to full membership is an observer member to represent all aquatic groups.

J. Kirk moved that A.S.L. appoint an Executive member on a reciprocal basis with A.M.S.A. executive, second D. Mitchell, passed.

16.2 Student Subsidy Committee Report - L. Barmuta, R. Marchant and B. Hart arranged that both students that applied receive assistance.

16.3 Fun Run Committee Report - J. Davis reported that the inaugural Fun Run was won by P. Breen and G. Morgan. An appropriate award should be found for winners of this event.

16.4 Door Prize Committee Report - L. Barmuta reported on the several possibilities for the Award before announcing the winners, as all those associated with the Fun Run. Unfortunately the Door was absent.

16.5 Window Award - I. Campbell awarded this to all those who watched the Fun Run. The Window was present.

16.6 D. Edwards moved that an honorarium of $300 be paid to M. Hart; second G. Ganf, passed.

16.7 I. Campbell thanked J. Kirk for his work as President over the past 15 months.

The meeting ended at 6.30 pm.

R. StClair
Secretary

ABSTRACTS, 24TH CONGRESS, WESTERN AUSTRALIA

AUSTRALIAN WETLANDS: CONSERVATION, DESTRUCTION OR EXPLOITATION

D.S. Mitchell, P. Breen, A. Chick and D. Short CSIRO Centre for Irrigation Research, Griffith, NSW

Present arguments for and against the conservation or utilisation of wetland areas are characterised more by emotion than reason. There are two main general reasons for this situation: insufficient knowledge of the structure and functioning of these systems and of their role in the Australian environment; and the application of different evaluation criteria for the various options.

This paper outlines the extent of our knowledge of Australian wetlands with special reference to the work being carried out on swamp systems in the CSIRO Centre for Irrigation Research and examines the major gaps in our understanding.

We emphasise the importance of the dynamics of water movement in these systems and of being able to calculate water balances. The mechanims of diffusion, especially of gaseous substances into and out of the sediment is similarly important.

We must understand nutrient retention and cycling mechanisms in order to recognise the ecological role of these systems and the potential for using them. Particular attention is given to these mechanisms.

In the end, the rationale for choosing between options for the use of wetlands and for selecting priority areas for research and development is dependent on sound and compatible environmental and socio-economic philosophies.

SOME QUANTITATIVE ASPECTS OF THE LIFE HISTORY OF AQUATIC INSECTS IN TEMPERATE AUSTRALIAN RIVERS

R. Marchant, Museum of Victoria, Abbotsford, Vic 3067

Little quantitative information on the life history of aquatic insects is available for rivers in southern temperate Australia. Data on the development periods of nymphs and larvae are accumulating for the Plecoptera and Ephemeroptera but little or no work has been undertaken on the other major orders such as the Tricoptera and aquatic Diptera. Studies on other quantitative aspects such as growth rates, egg development times and production have begun but compared with the northern hemisphere these topics remain virtually unexamined.

HORIZONTAL VARIABILITY AND MOTIONS IN LAKES AND RESERVOIRS

Jorg Imberger, Professor of Civil Engineering, The University of Western Australia

In smaller lakes and reservoirs in warm climates, thermal stratification plays a very important role. To first approximation this thermal stratification establishes a uniform, vertical, density gradient within the lake inhibiting vertical transfer of mass and momentum. Attention has so far focussed on the establishment and the de-stabilising of this vertical gradient. However, this vertical gradient when combined with horizontally patchy mixing can drive strong and important horizontal motions which would otherwise not exist. These motions have been shown recently to dominate both horizontal advection and horizontal mixing in medium and small lakes in warm climates.

We shall review new instrumentation and experimental techniques specifically designed to measure the mixing and the intrusional flow formed in a stratified lake. This equipment has been used to document horizontal variability and examples will be given of the extreme horizontal gradients present in most lakes.

The influence of a variable wind stress on the surface of the lake will be discussed and also the net amount of vertical entrainment induced by upwelling will be described and a new model presented. Motions due to thermal heating in a variable depth lake, differential heating and rectification of the diurnal heating cycle, are all shown to lead to strong horizontal motions which are able to transport boundary water to the centre of the lake. These mechanisms will be described and the importance for the biologist highlighted.

Lastly, a particular example of hypolimnetic flow will be described and the connection between flow and mixing will be highlighted.

ASSESSMENT OF METROPOLITAN WETLANDS - A METHOD

Dr Jennifer Arnold and Mr Ray Wallis, Department of Conservation and Environment, Perth

Wetlands are focal points for political conflict. This conflict arises as a result of differing perceptions of the value of wetlands. These perceptions may emphasise one or more of the following: wildlife habitat, wilderness, landscape, site for water-based recreation, resource for extractive industry, cheap source of land. At the same time many stresses are imposed on wetland ecosystems by urban development. The key to wetland survival is water, itself a resource subject to increasing demand.

The technique to be outlined sets out to identify factors which determine natural and social values of wetlands and the stresses which are imposed upon them. Responses to a series of questions are used as a means of classifying wetlands according to their stress and value scores.

EFFECT(S) OF FISH DENSITY ON ZOOPLANKTON IN A HATCHERY POND

Phillip T. Arumugam & Michael C. Geddes, Department of Zoology, University of Adelaide

This paper investigates the effect(s) of fish density on zooplankton composition and abundance in a hatchery rearing pond using 4 different densities of 27-43 mm standard length Golden Perch fry (0, 1, 2 and 15 fish m^{-2}). Each density was replicated 5 times using 4 m^2 rectangular enclosures as experimental units. The zooplankton abundance and species composition was monitored for 35 days at about weekly intervals. Fish samples were removed at intervals for stomach analysis and replaced with new fish accordingly. Results of the zooplankton abundance showed that (i) densities of Daphnia carinata and calanoid copepods decreased as the density of the fish increased; (ii) densities of Ceriodaphnia, Diaphanosoma and cyclopoid copepods increased as the density of fish increased; and (iii) densities of Keratella, Brachionus and copepod nauplii was higher in the 15 fish m^{-2} density as compared to the other fish densities. Comparison of zooplankton communities using a similarity index and cluster analysis showned that the 1 and 2 fish m^{-2} density communities were intermediate between the 0 and 15 fish m^{-2} densities. Stomach analysis showed that the zooplankton species eaten depended on the prey present.

INTERACTIONS BETWEEN SUBSTRATUM AND VELOCITY IN MACROINVERTEBRATE COMMUNITY STRUCTURE

L.A. Barmuta, Zoology, Dept, Monash Univ., Clayton 3168

Experimental patches of two different substratum sizes (phi-5 and phi-4) were allowed to colonize for 4 wk in 3 riffles (38 cm/sec) and 3 runs (11 cm/sec) and were compared with undisturbed substratum in the Acheron River, Victoria. No significant interaction ($p > 0.05$) between velocity regime and substratum type was detected for total numbers of invertebrates; velocity regime was the only significant ($p < 0.05$) main effect. Species richness showed some significant interactions but most information was conveyed by examination of community composition with experimental patches in riffles showing substantial differences from undistrubed patches. Contrary to previous suggestions, the substrata did not show consistent trends in the accumulation of detritus or fine sediments.

PESTICIDE BIOASSAY IN TURBID WATER

Kathleen H. Bowmer, CSIRO Centre for Irrigation Research, Griffith, NSW 2680

In turbid water, the transport, persistence and biological availability of many pollutants are profoundly affected by their interactions with suspended particulates and with benthic sediments. The question of bioavailability is particularly important for water management because information is required to answer the questions 'what is a tolerable level and will this change with water quality?' The subject will be discussed using data for glyphosate (N-(phosphonomethyl)glycine). This herbicide is increasingly used in minimum tillage, a practice valuable in reducing erosion; and also in aquatic weed control. I have not been able to demonstrate that phytotoxicity is reduced by adsorption or reaction in turbid water, although it could be expected from the literature. Problems of experimental methodology, interpretation, and application in water management will be discussed.

NUTRIENT PARTITIONING IN AN ARTIFICIAL WETLAND TREATING WASTEWATER

Peter Breen CSIRO Centre for Irrigation

Since the mid 50's considerable debate has existed over the potential for various wetlands to treat wastewaters. Many of the investigations to date have been performance assessment studies and have treated the system as a 'black box'. This is particularly true of artificial wetland systems.

This paper outlines the results from a preliminary mass balance study on an experimental scale, high rate, artificial wetland treating wastewater from a poultry rendering plant. Data is presented on treatment performance, nutrient partitioning and wetland plant species differences. The potential of artificial wetlands as wastewater treatment devices is discussed in terms of nutrient removal performance and identifiable nutrient sinks.

UNIQUE, UNIFORM OR UNINTELLIGIBLE? - SALINE LAKE PLANT COMMUNITIES

Margaret A. Brock, Botany Department, University of New England, Armidale

Are Australian saline lake plant communities be different from each other, from state to state or from other continents?

The submerged macrophyte flora comprises a small group of species tolerant of wide fluctuations of salinity and drying. Adaptations of morphology, physiology, life cycle and reproductive patterns enable plants to cope with environmental extremes and fluctuations. The plant species composition and community structure are remarkably homogeneous in a wide range of saline ecosystems across Australia. Why this difference between terrestrial and aquatic systems?

The similarities and differences of the aquatic macrophyte communities are compared and contrasted by examining ecosystems from Western Australia and South Australia and comparing them with ecosystems outside Australia (The Netherlands and New Zealand).

STREAMS OF THE NORTHERN JARRAH FOREST

Stuart E. Bunn, Department of Zoology, University of Western Australia

The catchment streams of the northern Jarrah forest and their benthic communities will be briefly described. The climate of this region is quite predictable by Australian standards and each year a hot, dry summer is followed by a mild, wet winter. Distinct summer and winter faunas can be identified and these are clearly associated with seasonal changes in the physical and chemical environment. Temporal changes in abundance, diversity and evenness, indicate that the invertebrate fauna of these streams becomes dominated by a few tax during the summer months. This seasonality and a high degree of spatial variation are seen as distinctive features of the communities of these streams. To conclude, an outline of work in progress on streams in Western Australia will be presented.

CONTROL OF NODULARIA ALGAL BLOOMS ON LAKE BULLEN MERRI

Frank L. Burns, Consulting Engineer, Glen Waverley, Vic

Lake Bullen Merri is a large saline crater lake of 180 000 ML volume, and 60m depth, near Camperdown in Victoria. It has been developed by the Fisheries and Wildlife Division as one of Australia's major Shinook Salmon and Trout fisheries. However, this development was being threatened by severe oxygen depletion each summer, as dense algal blooms of Nodularia formed over the surface from about November to April. These blooms also made swimming and water skiing in the lake very unpleasant, and it was declining rapdily as a tourist attraction.

The lake was also strongly stratified, with the thermocline at about 10m depth, and, in order to break up the stratification an aerator was installed in November 1982. This has proved very successful in maintaining good dissolved oxygen concentrations in the lake over the past three summers, and it is planned to convert this into a fully automatic electric powered installation next summer.

A major, and unexpected bonus from this mixing of the lake has been the elimination of the algal problem, which has now been repeated for three summers, and is obviously a direct result of operating the aerator.

The paper will describe the installation, and its operation, and attempt to explain the control achieved over the Nodularia.

MOULT STAGING IN THE AUSTRALIAN FRESHWATER CRAYFISH, CHERAX DESTRUCTOR, CLARK (DECAPODA, PARASTACIDAE), VIA UROPOD AND TELSON SETAE DEVELOPMENT

E.M. BURTON: Faculty of Applied Science and Technology, Warrnambool Institute of Advanced Education

The moult cycle of Cherax destructor has been divided into 13 substages using a method which combines changes in the morphology of uropod and telson setae and integument state. The duration of each substage has been measured under controlled conditions, thereby allowing quantification of the moult cycle. It is thus possible to estimate the time to ecdysis for any intact individual under certain conditions. As individuals are not harmed by this method of moult staging, it may now be possible to reduce the time required for growth and moult rate studies of C.destructor. The applicability of the method to Australian parastacids is discussed.

ASPECTS OF THE LIMNOLOGY OF SOME LAKES OF THE SWAN COASTAL PLAIN AND SOME IMPLICATIONS FOR MANAGEMENT

Bob Congdon, Botany Dept., Monash University, Clayton Vic.

The lakes of the Swan Coastal Plain have formed in the interdunal depressions of three old dune systems. In general the ionic composition of the water reflects the ionic ratios of sea water, although this appears to be altered by urbanizaion of the catchments. The mediterranean climate, with large seasonal variations in rainfall and evaporation, can produce large seasonal variation in water chemistry, which is further affected by the large year to year variability of rainfall. The biologically-conservative element chloride can be used as an indicator of variations in water level and lake volume. Data are presented for Lake Goollelal, to show that there is

seasonal variation in nitrogen and phosphorus concentrations, and phytoplankton standing crop, which is correlated with changes in water level. Chlorophyll a, organic phosphorus and organic nitrogen generally peak in late summer/autumn when water levels are lowest. Inorganic nitrogen and phosphorus concentrations were depressed at these times, peaking in winter to early spring. The lake was sprayed for the noxious aquatic weed Eichornia crassipes (Water Hyacinth) in January 1979. This resulted in large increases in phosphate, organic phosphorus and ammonium in late summer, with a phytoplankton peak in mid-autumn. Nutrient concentrations fell to "normal" levels within a month.

AUSTRALIA'S FRESHWATER HELIOZOANS (SUN ANIMACULES)

Roger Croome, University of Tasmania

Freshwater heliozoans occur in low numbers and, being outside the experience of most light microscopists, are often simply ignored. Routine electron microscopical examination of plankton samples has recently re-aroused world-wide interest in this group, particularly in those members possessing scales or other persistant features. A brief introduction to the organisms is given, and heliozoans found in various Australian lakes and swamps are illustrated.

MIXING STRUCTURES IN AN ESTUARINE RIVER

Nick DiAdamo, Department of Civil Engineering, University of Western Australia
Professor Jorg Imberger, Department of Civil Engineering University of Western Australia

The Murray River is located approximately 70 km south of Perth, Western Australia and flows into the Peel Inlet through a delta. Tidal influence extends to the Pinjarra Weir, 26 km upstream. The annual penetration of saline water from the Peel Inlet introduces a persistent density stratification and salt wedge. The breakdown of the stratification by normal environmental forcings such as wind, tide and solar heating is spatially patchy and temporally variable. This results in uneven mixing and the horizontal pressure gradients which are consequently set up between regions of variable density water drive horizontal advection currents.

This paper outlines the order of importance of the various environmental forcings to mixing in the Murray River Estuary. Data collected over the past few years which highlight the physical nature of some of the major mechanisms of mass transport in the river are presented.

THE FLOW ENVIRONMENTS OF BENTHIC STREAM INVERTEBRATES

Dr J.A. Davis, School of Environmental and Life Sciences
Murdoch University, Murdoch WA 6150

Water movement is the dominant physical feature of rivers and streams yet despite the very large amount of effort that has been devoted to research in lotic ecosystems few studies have attempted to describe lotic flow regimes in more than the most general of terms. The lack of data on benthic flow regimes is at least partly due to the difficulties involved in measuring velocities close to the streambed. In addition, the lack of a suitable literature spanning the disciplines of fluid mechanics and aquatic biology has created difficulties for biologists who may have wished to include detailed flow studies within their research programme but were uncertain as to which measurements to make or why. This problem has now been overcome, to some extent, by recent publications.

Recent work will be discussed and attention drawn to the fact that single mean velocity measurements per site are not enough to characterise benthic flow regimes. Instead velocity profiles and heights of roughness elements (substrate microprofiles) are required to enable the calculation of shear velocities, U*, roughness Reynolds numbers, Re*, and boundary layer thicknesses, &. In shallow water situations more detailed descriptions of three-dimensional flow patterns around benthic obstacles (boulders) are also required.

MULTIVARIATE ANALYSIS OF MACROINVERTEBRATE COMMUNITIES IN THE GOULBURN RIVER AND TRIBUTARIES ABOVE LAKE EILDON, VICTORIA

T.J. Doeg, Biological Survey Department, Museum of Victoria

A set of ten kick samples were collected in June 1984 at each of 17 sites in four rivers draining into the south-eastern arms of Lake Eildon. A total of 176 macroinvertebrate tax, from 5 phyla and 8 classes was identified. The majority of the tax (153 or 85%) were insects, in 7 orders and 42 families. The high diversity and composition of the fauna compared favourably with other studies of similar, relatively undisturbed sites in Victorian river systems. There were no significant differences between the total number of tax taken at each site. However, ordination by de-trended correspondence analysis (DECORANA) and classification by two-way indicator species analysis (TWINSPAN) detected differences between the species composition at sites affected by human settlement activity and those in less disturbed natural vegetation. The differences seemed to be due to variations in a number of tax (e.g. Atalophlebioides sp.) which may prove valuable as indicators of relatively clean water quality and undisturbed substratum conditions.

The new ordination and classification techniques used seem to be a potentially valuable and powerful tool in ecological research and monitoring, having the advantages of not requiring many assumptions as to the distribution of the raw data, overcoming statistical problems associated with previous methods, and most significantly, being easy and quick to use by computer illiterates.

THE EFFECTIVENESS OF HIGH-RATE MACROPHYTE TREATMENT SYSTEMS IN HEAVY METAL REMOVAL

Janet Dunbabin, Kathleen H. Bowmer CSIRO Centre for Irrigation Research, Griffith, NSW 2680

High-rate macrophyte treatment systems, where effluents are percolated through the root zones of emergent macrophytes growing in a gravel substrate, are being used to remove nutrients from rural and urban effluents. A similar treatment system, using Typha domingensis, is being investigated for treating mining industry waste waters. Typha is not itself an effective scavenger of metals from effluents in which it is grown. Instead it influences metal immobilisation by modifying physical, chemical and biological conditions in the substrate as it grows. To understand the effects of these modifications to the root zone, a series of small gravel-based flow through systems were designed. They examined the effects of pH, redox potential, dissolved oxygen, organic carbon and nitrogen source on the removal of copper, zinc, cadmium and lead by both Typha and the substrate in which it grew. Substrate removal exceeded plant uptake, but varied with changes in physicochemical conditions caused by the presence of plants.

MANAGEMENT OF THE MAGELA FLOODPLAIN, NT - THE SIGNIFICANCE OF RECYCLING BY AQUATIC PLANTS

Max Finlayson: Office of the Supervising Scientist, Alligator Rivers Region Research Institute, Jabiru NT

The Magela Floodplain is in the World-Heritage-listed Kakadu National Park located east of Darwin. It has an area of 250 km^2, experiences a monsoonal climate and supports about 76 plant species that can survive the annual flooding and drying of the plain. Management problems include the release of excess water and chemical wastes from the Ranger Uranium Mine. One of the ecological questions raised by a release of such wastes is that of the effect and fate of their constituents. Four plant communities - Pseudoraphis spinescens, Hymenachne acutigluma, Oryza meridionalis and Melaleuca spp. - were sampled over a 17 months period to determine the extent of accummulation and of natural recycling of selected chemicals by the floodplain vegetation. These

values have been related to the loads contained in the floodplain sediments and the stored water at the minesite.

SELECTIVE FEEDING BY DAPHNIA CARINATA

George Ganf and Russell Shiel, Botany Department, University of Adelaide, Adelaide SA 5001

Daphnia carinata was shown to positively select 9 um in preference to 18 um DVB beads when both were presented in mixed culture. However, this selection could be partially reversed by flavouring 18 um beads with algal extracts. These data suggest both a mechanical and a chemosensory basis to particle selection. Further experiments investigated the trapping of particles the diameter of which was less than the intersetular distances of the third and fourth limbs.

OSMOREGULATION IN LARVAL BRINE SHRIMP

Michael C. Geddes, Zoology Department, University of Adelaide

There are several species of the Australian brine shrimp, Parartemia, in Australian salt lakes, including two species that appear to be restricted to acidic salt lakes. Osmoregulation has been studied in adult P. zietziana but there is no information on larval brine shrimps. Experiments on the salinity tolerance of P. zietziana nauplii show lower and upper LD50 values of 1°/oo and 226°/oo. Two lines of evidence suggest that the larvae are osmotic regulators in these media. Scanning Electron Microscope studies show that the nauplius larvae have a dorsal gland which is presumably used for osmoregulation. Experiments with the enzyme inhibitor ouabain indicate the presence of a sodium pump based on Na-K ATP which is necessary to allow survival in concentrated media. A bioenergetic model has been proposed for osmoregulation in nauplii of the cosmopolitan brine shrimp Artemia in which ATP production is enhanced through a facultative pathway involving an aerobic glycolysis which requires CO_2-fixation. This model will be discussed with particular reference to the problems faced by brine shrimp in acid salt lakes.

ON ESTIMATING THE ABUNDANCE OF FRESHWATER TURTLES

Arthur Georges, Water Research Centre Canberra CAE, PO Box 1, Belconnen 2616

An intensive mark-recapture study, with traps set on a regular grid, was conducted on a Fraser Island population of Krefft's River Tortoise, Emydura krefftii. The population was closed

for the duration of the study and this, combined with high sampling intensities (93% recapture rates at study's end), provided a rare opportunity to test the validity of methods traditionally used to assess the abundance of freshwater chelonians.

Variation in risk of capture among individuals introduced a severe bias to the Peterson Method (= Lincoln Index), with progressive estimates depending more on the number of animals marked at time of sampling than on true population size. Realistic estimates were not obtained until at least 75% of the population had been marked. Contrary to expectations, the Frequency-of-Capture Methods, based on truncated Poison, Binomial, Negative Binomial and Geometric Distributions, and purported to be free of the assumption of equal catchability, were as ineffective as low and moderate sampling intensities as the Peterson Method.

This and other studies have established that turtles can be very abundant in fresh waters and the lack of prominence given turtles in many limnological studies appears undeserved.

THE INFLUENCE OF ENVIRONMENTAL VARIABLES ON THE DENSITY OF LARVAL LAMPREYS IN DIFFERENT SEASONS

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SUMMARY: The objective of the study was to identify which of twenty environmental variables were required to explain variations in the density of the larvae of the lamprey, Geotria australis, in a south-western Australian stream (Carey Brook, near Pemberton).

Generalised linear modelling incorporating a Poison error (using the "GLIM" system package, National Algorithm Group, Oxford), indicated that the influence of the environmental variables altered with season. Variations in the density of larvae in each of the four seasons could be attributed to the effects of a combination of between five and nine environmental variables. The influence of stream region was also important in the model for winter.

Four environmental variables (substrate organic material and chlorophyll a, the presence of macrophyte roots and low-angle shading) were present in three of the four seasonal models. A further seven variables (water depth, current velocity, substrate depth and profile, medium-sized sands, light intensity, and the presence of an eddy) were each required for two models. Eight variables never made a contribution to any seasonal model.

The results of the models were shown to be biologically meaningful and agree with the traditional assessments made by many workers for other lamprey species in diverse geographical localities.

THE APPLICATION OF MICROTOX IN THE MANAGEMENT OF AN ENVIRONMENTAL EMERGENCY

A.L. Hinwood and M.J. McCormick, Department of Applied Chemistry, Royal Melbourne Institute of Technology

Traditional chemical and biological tests are often too time consuming to provide useful data for rapid decision making in environmental emergency situations.

The Microtox test however is a simple, rapid, but effective means of indicating toxicity.

Such data have been used in the management of a situation in which large volumes of contaminated water threatened to pollute a water course after a major fire involving hazardous chemicals in the Western Suburbs of Melbourne.

This paper describes how the results of Microtox tests together with those of conventional chemical analyses were used to:

- provide information on possible disposal strategies
- evaluate various treatment options
- estimate any residual hazard after initial treatment and/or removal of water and contaminated sediment had been undertaken.

IMPACT OF MINING ON FISHES OF THE OK TEDI-FLY RIVER SYSTEM, PAPUA NEW GUINEA

Kent G. Hortle, Ok Tedi Mining Limited, TABUBIL W.P. Papua New Guinea

Sampling of fish has been carried out a nine localities in the Ok Tedi-Fly River System since mid 1983. Using standardised methods, (gill netting, seining and trapping), over 20 000 fish in about 70 species have been collected to date. Analyses of gut contents and gonad condition have been carried out on about 8000 fish, while analyses for tissue metals (Cd, Cu, Pb, Zn, Fe, Mn) have been initiated for about 2000 fish.

Initial assessment of the resulting large biological data base indicates that sediment derived from construction activities (commencing July 1982) reduced numbers of some sensitive fish species as far as Ningerum, (76 km downstream of the mine and 1100 km from the river mouth). Recovery occurred through 1984

and 1985, despite commencement of mining, and discharge of treated, cycloned tailings. The major impact of sediment appears to be due to the coarse fraction (| 150 um) with most fish species tolerating median suspended sediment levels of c. 500 mg/l and peak levels of c. 10 000 mg/l.

The arid catfishes, Arius acrocephalus and Hemipimelodus taylor appear to be favoured by high sediment levels. Rainbowfish (Melanotaenia splendida), herrings (Clupeoides spp), glassfish (Ambassis reticulata and Parambassis gulliveri) and garfish (Zenarchopterus novaeguinae) are all tolerant of these levels of suspended sediment, and appear to avoid exposure to very high levels by moving to tributary mouths. Several species which feed on aquatic insects appear relatively intolerant. These include gobies (Glossogobius spp), mouth almighties (Glossamia spp) and grunters (Hephaestes spp). The detritivororous mullet, Crenimugil labiosus, also appears to be intolerant of high concentrations of suspended sediments.

BURROWING FRESHWATER CRAYFISH: SOME ASSOCIATION OF HABITAT, LIFE HISTORY AND MORPHOLOGY

P. Horwitz, Zoology Department, University of Tasmania

SUMMARY: The habitat of Australian freshwater crayfish can be categorised into four distinct types, depending on the degree to which an animal shelters or burrows in a water body, away from a water body but associated with a water table in the soil, or independent of a water table. Similarly, crayfish themselves can be classed as either primary, secondary or tertiary burrowers (sensu Hobbs 1942, 1981; with modifications) depending upon the amount of time a species spends in open water or in burrows and any seasonality associated with this. If these two schemes are amalgamated, 8 classes or degrees of 'burrowingness' can be defined. To test the validity of these, aspects of crayfish morphology which are known to be linked with burrowing or open water dwelling adaptations are plotted and the trends described. The implications of these trends on the knowledge of Parastacid phylogeny are briefly discussed.

A HYDROLOGICAL CLASSIFICATION OF TASMANIAN RIVERS

Jocelyne M.R. Hughes, Department of Geography University of Tasmania

Annual flow records, monthly flow records, peak discharge series and low flow discharge series were obtained from Tasmanian rivers. Twelve hydrological indices were determined from these data. The 12 x 77 matrix was analysed using principal components analysis and Ward's sum of squares method,

and a classification of the riverine hydrology of Tasmania was derived. The driest region of the island exhibits regimes similar to those of the drier mainland areas, while the wettest areas have regimes with no analogue within Australia. Such hydrological diversity has far reaching consequences for the biogeography and ecology of streams and rivers in Tasmania.

TRACE METAL COMPLEXING CAPACITY OF NATURAL WATERS - ITS MEASUREMENT AND APPLICATION

M.J. Jones, H.R. Daly and B.T. Hart, Water Studies Centre, Chisholm Institute of Technology

A number of methods have been developed to measure the copper complexing capacity of natural waters. These have been applied to waters from the Magela Creek in Northern Australia and three waters from Victoria. The values obtained for the complexing capacity and conditional stability constants of the copper-organic complexes differ markedly between the methods. Reasons for the differences are advanced.

The results from two of the methods, employing anodic stripping voltammetry (ASV) and an ion selective electrode (ISE), have been combined to calculate copper speciation in the waters. Assuming that the free copper ion is the toxic form of the metal, these results have been compared with those obtained from toxicity tests using the freshwater shrimp Paratya australiensis. The comparison indicates that parameters such as trace metal complexing capacity may be important when assessing the impact of trace metals in aquatic systems.

APPROACHES TO DETERMINING HABITAT REQUIREMENTS FOR FRESHWATER NATIVE FISH IN VICTORIA

John Koehn, Arthur Rylah Institute for Environment Research

SUMMARY: Work being undertaken by the Stream Ecology Group of the Arthur Rylah Institute for Environmental Research is designed to develop techniques and to determine the habitat preferences of some species of Victorian freshwater native fish, in particular freshwater blackfish (Gadopsis marmoratus).

Work for the program is being conducted at a study site consisting of 52 adjoining sections of homogeneous habitat in Armstrong Creek. Each section is electrofished, the fish are removed and their positions marked on a map of each section. Measurements of stream flow are taken and maps showing the categories of habitat in each section are drawn. Multiple regression analyses combining fish data and habitat parameters, along with habitat criteria obtained from fish positions provide habitat information.

Although detailed analysis of the results is not yet complete, preliminary analysis indicates that freshwater blackfish prefer water of slow velocity (19 cm/sec) where wood debris is present.

INTERACTIONS BETWEEN FISH AND CHIRONOMIDS AT DIFFERENT SALINITIES

Michael Kokkinn, Department of Zoology, The University of Adelaide

The chironomid midge, Tanytarsus barbitarsis Freeman, was studied over a two-year period in an ash-disposal lake at Port Augusta, South Australia. The hardyhead fish, Atherinosoma microstoma (Gunther, 1861), is an important predator of the midge, particularly as first instars and pupae. During the first year of study (1982/83) water salinities rose to 80 p.p.t. (TDS) during early summer causing heavy mortality among larval and juvenile fish. This resulted in a release of predation on the midge population which was then able to increase to large numbers during that summer. Because of increased pumping by the power station during the following year (1984/85), water salinities were held below 50 p.p.t. (TDS) throughout the summer. This resulted in a higher fish recruitment which placed heavy predation pressure on the planktonic first instar midge larvae. Consequently, there was a lower number of midges in the population during the 1984/85 summer. These patterns indicate that the period of fish recruitment is important with regard to the population dynamics of T. barbitarsis.

GARRETT & AWRAMIK REVISITED: THE STROMATOLITES OF LAKE CLIFTON, WESTERN AUSTRALIA

Brenton Knott, Zoology Dept. University of Western Australia

Garrett and later Awramik have suggested that the decline in diversity and abundance of stromatolites at the end of the Proterozoic resulted from the original diversification of grazing and burrowing metazoans which occurred at that time. Their hypothesis is reviewed here in light of the abundance and diversity of metazoans inhabiting the so called stromatolites at Lake Clifton, an interdunal lake south of Perth, Western Australia.

WATER QUALITY STANDARDS - ALLIGATOR RIVERS REGION

Dr Glen Riley, Research Institute, Jabiru, Northern Territory

Prior to 1970, the Alligator Rivers region supported the indigenous people, seasonal buffalo shooters, small-scale mining (in the early 1960s) and the very rare tourist. By the mid-1980s, the Aboriginal population has increased, two large uranium mines commenced and tourism developed as a consequence of the declaration of Kakadu National Park. These land use changes will inevitably cause some environmental modification. The OSS, charged with the responsibility of ensuring environmental protection with respect to uranium mining and milling, has developed an approach that could lead to receiving water standards for the environment downstream of the two uranium mines.

The approach taken is to consider the protection of man and the protection of the ecosystem as separate entities. Ingestion of traditional food by Aboriginal people leads to the derivation of model dependent annual loads that could be tolerable in the stream system. Ecosystem protection is explored firstly by proposing that concentration increments in streams be constrained to lie within natural seasonal variations and secondly, an ecological assessment be carried out on those elements or radicals which are unavoidably enhanced in the mining environment.

WATER AS A CONTROLLING FACTOR IN THE DISTRIBUTION OF TYPHA

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The biomass of a natural population of T. domingensis was positively correlated with indices of water availability. In the laboratory water availability was simulated using solutions of polyethylene glycol (PEG) as a matricum. Typha shoots were grown in two different water regimes for 30 days. Growth and water loss were directly related to water potential. High water loss rates per unit leaf area coupled with naturally large leaf area mean that only under saturated soil conditions is there sufficient water available to maintain growth. Stomatal control appears to be minimal. This explains the observed field distributions of Typha.

CYCLOMORPHOSIS IN THE DAPHNIA CARINATA COMPLEX

John Benzie, Research School of Biological Sciences Australian National University, Canberra

Cyclomorphosis occurs in two of the three species in the D. carinata complex in Australia, D. carinata and D. cephalata. A detailed description of seasonal variation in crest size in clones identified by electrophoretic markers showed cyclomorphosis in both species to be the result of phenotypic plasticity and not a seasonal succession of clones. Field experiments showed that predator (Anisops) abundance and food levels controlled crest size in D. carinata. Food alone appeared to control crest size in D. cephalata, but in both species the ultimate factor considered responsible for the evolution of crests was predation.

PHOSPHORUS AND THE CULTURAL EUTROPHICATION OF FRESHWATERS: REALITY AND ILLUSION

Tom Berman, Centre for Water Research University of Western Australia

In many lakes and reservoirs, particularly in the north temperate zone, phosphorous (P) has been shown to be the major nutrient which limits phytoplankton growth. Consequently much research effort has been invested in studies of algal P uptake and utilisation, and the characterisation of indicators of P nutritional status. Nevertheless, in many other cases, other nutrients such as nitrogen, silica or metals may act to determine both the quantitative and qualitative aspects of the phytoplankton assemblage. Some examples will be mentioned. The moral is that caution is emphasised in advocating P limitation as a sole environmental control strategy for water quality management.

CHEMICAL STRATIFICATION IN IMPOUNDMENTS OF THE PIEMAN RIVER POWER DEVELOPMENT, TASMANIA

L.C. Bowling

Three reservoirs, Lakes Mackintosh, Rosebery and Murchison, have shown chemical stratification since flooding, with rising conductivity, bicarbonate, calcium and magnesium in the bottom waters, by a dramatic shift in redox potentials from oxic to reducing conditions, and increase in dissolved iron, manganese and sulphides. Chemical stratification was of a temporary nature in Lakes Mackintosh and Rosebery during the first summer after filling, but has persisted since 1982 in Lake Murchison. The persistence or decay of this meromixis can be explained by

differences in basin morphometry and alignment to prevailing winds.

PHOSPHORUS RETENTION IN HARVEY ESTUARY, WESTERN AUSTRALIA

R.J. Lukatelich

Centre for Water Research and Botany Department, University of Western Australia, Nedlands, WA 6009

Large blooms of the blue-green alga Nodularia spumigena have occurred in Harvey Estuary each spring, since 1980. The magnitude of the Nodularia bloom appears to be related to river phosphorus load in the preceding winter. However, in winter, the period of major (~90%) phosphorus input to the system, Nodularia growth is limited by temperature. Nodularia, therefore, relies on phosphorus recycled from the sediments. At the present time the sediment supply of available phosphorus is not large enough to support a Nodularia bloom unless it is supplemented by the current year's riverine input.

A study was carried out in July - August 1983 to determine the amount of phosphorus that is trapped in the Harvey Estuary during a normal flood event, and to determine the major mechanism by which the phosphorus is trapped for later utilisation by blue-green algae. The results of this study will be presented here.

Almost all (|95%) of the phosphate phosphorus, the dominant form in which phosphorus enters the Harvey via river flow, which entered the Harvy during the study period was taken up by the phytoplankton.

WATER QUALITY TESTING WITH CLADOCERA

Patrick McBride, Office of the Supervising Scientist

SUMMARY: Local (Northern Territory) cladoceran species; Diaphanosoma excisum, Echinisca triserialis?, and Moinodaphnia macleayi were found to be highly suitable for short-term sublethal laboratory tests of water quality, especially the toxic properties of low concentrations of uranium in water. Assessment of effect was based on the number of young produced over a period by individual animals kept in small (15 ml) containers. Rapid population growth by parthenogenesis (up to 40% per day) enabled a test result to be obtained within 10 days and the simple requirements and small size of the animals enabled sufficient replications of each test for statistical analyses of the results.

NUTRIENTS AND PLANT BIOMASS IN SOME WESTERN AUSTRALIAN AQUATIC SYSTEMS

A.J. McComb, Botany Department and Centre for Water Research University of Western Australia, Nedlands WA 6009

This paper serves as an introduction to the more prominent groups of plants in south-western Australian water bodies, and discusses their responses to nutrient enrichment. Some attention is given to eutrophication of freshwater lakes and marine embayments, but most of the review will deal with estuaries. The effects of nutrient enrichment on seagrasses, macro-algae and phytoplankton will be described, and the role of fringing vegetation in nutrient availability in the open water discussed.

WETLANDS OF THE PILBARA, WESTERN AUSTRALIAN

Ray Masini, Botany Department, University of Western Australia

A survey of wetlands in the Pilbara region of Western Australia was undertaken to:

(1) identify and document them in terms of their physical and biological characteristics, and

(2) develop a preliminary classification system for wetlands in the region.

During the field work over 60 sites were visited and, from the results of the survey, 9 wetland types were tentatively identified. Details of the wetland types and characteristics useful in their classification are presented.

CATASTROPHIES AND COMPULSIVE EATING IN FRESHWATER PLANKTON

Chester Merrick, Botany Department, University of Adelaide, Adelaide, SA 5001

Regular monitoring of Mt. Bold Reservoir indicated that some phytoplankton species disappear from the water column within a short time period. Intensive sampling was done over the 1984/1985 summer to see if this was a result of previously localised sampling. This showed that particular species declined catastropically in the reservoir at rates of -0.5 ln units day^{-1}. Examination of the thermal stability of the reservoir during this period discounted sinking as the major cause of these losses. Measured increases in zooplankton densities and their potential grazing rates would result in the observed elimination of the phytoplankton species. Previous

exclosure experiments demonstrated the ability of zooplankton to selectively graze phytoplankton species. The potential for zooplankton to rapidly change the composition of the phytoplankton community is apparent.

POSSIBLE FACTORS INVOLVED IN THE INITIATION OF STROMATOLITES

Linda Moore, Department of Microbiology, University of Western Australia

Stromatolites are organosedimentary structures constructed by sediment trapping, binding and/or precipitation as a result of the growth and metabolic activity of benthic microbial communities. The discovery of these structures in Lake Clifton, 100 km south of Perth, has instigated a multi-disciplinary research programme aimed at determining the factors which initiate and support stromatolite growth in this environment. In Lake Clifton, the growth and distribution of the stromatolites appears to be associated with a fresh groundwater intrusion on the eastern shore of the lake. Surface water chemistry data show that the ionic composition of Lake Clifton and the other ten lakes of this interdunal complex is proportionally the same as that for seawater. Salinity, however, is markedly different for each lake, Clifton being the least saline. The groundwater is relatively fresh and enriched in calcium and bicarbonate as a consequence of its origin.

The effect of increased calcium and bicarbonate input into the lake and its relation to the precipitation of calcium carbonate is presently under investigation. Preliminary work has begun on the use of stable carbon isotopes to determine the extent of biologically mediated precipitation of carbonate in the formation of stromatolites. Research is also concentrating on the infiltration of the groundwater into the sediments and whether this may be a prerequisite for the initiation of stromatolites. Preliminary comparative studies of a number of lakes in South Australia indicate that the presence of a groundwater input is a common factor in what are otherwise quite different stromatolite environments.

ASSESSING THE INFLUENCE OF SUSPENDED PARTICULATES ON PHYTOPLANKTON GROWTH IN TURBID WATER

R.L. Oliver, CSIRO Centre for Irrigation Research Griffith NSW

Algal growth in primarily fuelled by the availability of light and nutrients. The acquisition and utilisation of both these resources is affected by the presence of suspended particulates. Algal growth potential is being assessed through investigations of the underwater light regime coupled with the use of "standard" bioassays to determine the availability of

soluble nutrient pools, and bioassays in two-chambered membrane diffusion vessels to determine the availability of particulate nutrient pools. The interplay of these factors is decisive in determining the potential for excess algal growth and will be discussed in relation to the turbid waters of the highly regulated Murrumbidgee River.

PHOTOSYNTHESIS OF MYRIOPHYLLUM SALSUGINEUM, A GROWTH PARADOX

Orr, P.T., Pokorny, J. and Erskine, D.J.C, CSIRO Centre for Irrigation Research, Private Mail Bag Griffith NSW 2680

Measurements of net photosynthesis of Myriophyllum salsugineum Orchard have demonstrated a high temperature optimum of 30-35°C for this plant. However, the observed distribution of Myriophyllum salsugineum in cooler fresh and mildly brackish waters of southern coastal Australia suggests - as also appears to be the case fo the very closely related species, and noxious Tier 1 aquatic weed Myriophyllum spicatum L. - that the observed high temperature optimum for net photosynthesis does not represent the optimum growth temperature. Factors affecting the growth of aquatic plants will be discussed with special reference to Myriophyllum salsugineum. The interim results of a simple light/temperature/photoperiod model being used to try to explain the apparent discrepency between optimum temperature for photosynthesis and observed distribution of Myriophyllum salsugineum will be briefly discussed.

THE ROLE OF NUTRIENT ENRICHMENT IN A REVERSED HYDROSERE: A VIEW FROM THE SEDIMENTS

P.L. Osborne and N.V.C. Polunin, Biology Department, University of Papua New Guinea

Changes in the freshwater vegetation have taken place since the 1950s in Waigani Swamp, near Port Moresby, Papua New Guinea. The records of diatom assemblages and plant remains in sediment cores confirm that the lake was dominated by a mixed, emergent swamp, that this was replaced by floating-leaved plants and that the latter have given way to the present open water condition. Alteration of the aquatic flora can most readily be explained by nutrient enrichment (which predates the vegetation changes) and water-level changes in the lake. These two influences can not be separated easily because the same cause - increase in sewage and urban run-off with human development in the catchment - has led to both. It is unlikely that either mechanism alone can explain the whole sequence of changes that has occurred, but the two together may do this adequately.

LONG TERM BIOLOGICAL MONITORING OF THE YARRA RIVER, VICTORIA, USING MACROINVERTEBRATES: THE FIRST YEAR

Vincent Pettigrove, Rural Water Commission, Victoria

Ten sites, consisting of 6 pools and 4 riffles were established within the Yarra River Catchment for long-term biological monitoring of macroinvertebrates. Nine sites were located on the Yarra River and one on the Woori Yallock Creek. The sites ranged from a predominantly intact riffle upstream of the Upper Yarra Reservoir to an urban riffle below the man-made Sights Falls. All sites were sampled twice (Dec. 1983 and July 1984).

The significance of faunal composition and distribution was assessed using average species richness, two species richness indices, two heterogeneity indices, Brown's Lognormal Distribution Model of Pollution Stress, Hocutt's Ordination Method and cluster analysis.

Each site was dominated by a characteristic macroinvertebrate community which was similar for both sampling periods. The only major taxonomic groups to exhibit any temporal variation within these periods were Mollusca and Plecoptera which were more abundant in July 1984.

Although there was a general pattern of deterioration in the macroinvertebrate communities downstream, the rate of deterioration was particularly high in the following two regions; between sites Upper Yarra and Upper Woori Yallock, and Warrandyte and Alphington.

ARTESIAN SPRINGS - A DISAPPEARING ENVIRONMENT

W.F. Ponder, Australian Museum, Sydney

Numerous artesian springs are found around the periphery of the Great Artesian Basin in northern south Australian and Western Queensland. Some of these springs contain endemic species and genera of molluscs, crustaceans, fish and flatworms. A recent survey of the artesian springs in western Queensland revealed that many have been destroyed, or are on the brink of destruction, largely as a result of drawdown caused by excessive extraction of artesian water from bores. Considerable direct damage is also being inflicted by man and stock. Many of the springs in South Australia are also declining and under threat although, recently, some conservation measures have been proposed in that State. Artesian springs present in north western New South Wales around the turn of the century are now all extinct. Will this be the situation with the majority of artesian springs by next century?

LOCAL DISTRIBUTIONS OF CRAYFISH IN SW TASMANIA

Alastair Richardson, Department of Zoology, University of Tasmania

Two forms of the Tasmanian endemic burrowing crayfish Parastacoides co-occur widely in south west Tasmania. Detailed examination of a small area shows that their burrows can be recognised reliably and that they may be found at very short distances from each other (less than 1m). Correlations between the density of the two forms and parameters of the habitat are described and long term persistence (over 7y) of the burrows can be demonstrated. The two forms are currently given subspecific status, but they should be raised to specific rank.

INSTREAM FLOW REQUIREMENTS FOR FRESHWATER FISH

Barbara Richardson, NSW Department of Agriculture, Division of Fisheries

Several methods for determining instream flow needs for freshwater fish have been used in New South Wales. The suitability of these methods is presently being investigated and further development of methods is necessary to provide adequate approaches for the wide variety of Australian river systems. The advantages and disadvantages of the available methods are discussed.

Methods based purely on historical average annual flows and flow duration curves are only suitable for planning or to ensure initial recognition of streamflow needs. Specific site studies are necessary for all major water developments. Two quantitative approaches were tested to assess their suitability for determining instream flow needs; a multiple transect analysis and the Incremental method. The major factors influencing the adequacy of these methods are channel morphology and stability, conflicting water usage and availability of water, and most importantly, the paucity of information available on biological and behavioural responses of aquatic species to streamflow.

THE AMPHIBIOUS SNAIL AUSTROASSIMINEA LETHA AND THE FRESHWATER SEEPAGES OF THE LEEUWIN-NATURALISTE AREA, WA

S.M. Slack-Smith, Western Australian Museum

Newly discovered populations of the prosobranch Austroassiminea letha Solem, Girardi, Slack-Smith and Kendrick, 1982 which are associated with freshwater seepages at Cape Leeuwin and Gnoocardup, bring the total to six.

The Gnoocardup seepage is the largest known habitat of this snail, whose known geographic range is apparently now confined to the coastal zone between Ellen Brook and Cape Leeuwin. This habitat has an area of less than 0.25 hectares, greatly exceeding all but the 'Ellensbrook' habitat.

The snails can aestivate for long periods in cool still situations but can rapidly detect increasing humidity and become active. They breed in winter.

Suitable habitats are apparently associated with seepages of high pH which, if seasonal, are very close to the sea, with the availability of refuges from summer heat and winter flooding, and with the availability of a food supply of dead plant material.

The paucity and isolation of populations of this snail indicate the need to preserve such vulnerable habitats.

PERTH URBAN WATER BALANCE STUDY: A STUDY FOR THE MANAGEMENT OF PERTH'S GROUNDWATER RESOURCES

Graeme R. Smith, Centre for Water Research, University of WA

Concern arose in the low rainfall years of the late 70s for the ability of Perth's groundwater resources to meet the demand placed upon them by the rapidly increasing number of bores and wells in the Metropolitan area. The Perth Urban Water Balance Study was established to identify whether there was a need to carefully manage Perth's groundwater resources. This address presents the aims of the Study and the techniques used to evaluate features which are or may come under stress from varying groundwater levels. Techniques for evaluating optional management strategies are also presented, along with some consideration of work that may need to be carried out after the conclusion of the Study.

DIETS OF LEPTOCERID CADDIS LARVAE FROM VICTORIAN STREAMS

Ros St. Clair, Zoology Department, Monash University

The diets of 13 species of Leptoceridae from Victoria are discussed. Diets were determined using gut analysis and field and laboratory observations. The majority of species studied are shredder/detritivores but wood, animal matter and green plant material are also eaten.

The relationship between food items and seasonal litter inputs in upland forested streams is briefly discussed.

ASPECTS OF WATER QUALITY AND DESTRATIFICATION AT DARTMOUTH RESERVOIR

David R. Welsh, Rural Water Commission, Victoria

Dartmouth Reservoir on the Mitta Mitta River in North Easter Victoria remains chemically stratified despite the absence of any thermal barrier to mixing during the isothermal periods of each winter. The resulting anoxic monimolimnetic pool has been disturbed on just two occasions by the inflow of cold, oxygenated waters along the bottom of the storage.

The accumulation of particulate matter, iron, manganese and hydrogen sulphide in the monimolimnetic pool has impaired the quality of the water released from the Low Level Outlet to the river downstream of the dam.

Artificial aeration has failed to destratify the reservoir to date, primarily due to a constriction in the air line from the compressor. However, a simple mathematical model suggests that temperature objectives may not be achievable by destratification.

LIMNOLOGY OF AN UNPREDICTABLY-FILLED SALINE LAKE: LAKE EYRE, SA

W.D. Williams, Department of Zoology, University of Adelaide

Lake Eyre is a huge playa in the north of South Australia. Essentially there are two basins connected by a narrow channel. Both contain water rarely. Lake Eyre North has done so within living memory only three or four times. In January 1984, an unusual event took place. Above average rainfall around Lake Eyre South resulted in the filling of that playa from local run-off. The subsequent changes in water chemistry and faunal composition were monitored monthly from February until the playa dried in January 1985.

The nature of chemical changes will be discussed in detail in the paper. Salinity went from 27.6°/oo to 1300°/oo. The invertebrate fauna was depauperate. Mainly, it comprised species of Tanytarsus, Parartemia, Moina, and ostracods. An important part of the rationale for the investigation was to determine whether results supported the hypothesis that only predictably-filled salt lakes have diverse and regionally endemic faunas, and that unpredictably filled salt lakes (such as Lake Eyre) have depauperate faunas consisting of widely spread species.

FISH PRODUCTION IN SEWAGE PONDS - A SOUTH AFRICAN EXPERIENCE

Tim J. Wrigley, Murdoch University

Four $10m^3$ pilot scale, waste stabilisation ponds linked in series were stocked with fish. In the first three ponds Clarias gariepinus were stocked. In the fourth pond, on various occasions, combinations of Oreochromis mossambicus; Hypopthamichthys molitrix, Cyprinus carpio and Labeo umbratus were stocked.

During summer, O. mossambicus and C. carpio grew at an average daily rate of 1.4% and 2.1% body weight respectively, while in winter both H. molitrix and L. umbratus lost weight and C. carpio daily growth was reduced. Small C. gariepinus (2g) grew rapidly in summer at a daily rate of 5.9%, however, during winter, growth was reduced to 0.2% body weight d^{-1}. Large C. gariepinus (|300g) grew throughout the year averaging increases of between 0.5% and 0.7% body weight d^{-1}.

These yields could possibly be higher except that on the highveld of South Africa, low winter temperatures and low dissolved oxygen concentrations during Spring restrict the growing season of these species. High ammonia concentrations also may have been responsible for mass mortality of fish during summer.

Large reductions in Total Suspended Solids, Chlorophyll a and Chemical Oxygen Demand were achieved in the fourth pond, though what effect fish had on these reductions was not conclusively determined. Fish stocking in the fourth pond did not appear to have a substantial effect on zoo- and phytoplankton populations, consequently the water quality of the effluent was subject to the change in frequency and intensity of these populations.

TRACE METAL SPECIATION IN LAKE MURRAY SEDIMENTS

James K. Kyle, W.A. School of Mines, PO Box 597,
Kalgoorlie WA 6430

The speciation of iron, manganese, copper, zinc and lead in the 63um fraction of the bottom sediments of Lake Murray has been investigated. Cadmium (0.1 ug g^{-1}) and mercury (0.07 ug g^{-1}) were not present in sufficient quantities to allow a study of their speciation. A sequential chemical extraction procedure identified 3 chemical phases labelled as reducible, organic and residual. A large proportion (53%) of the total iron (53 900 ug g^{-1}) was in the reducible phase. (-GO-TO-GL-)lcentration of reducible iron, probably amorphous iron oxyhydrates, would play an important role in the initial binding and later remobilisation of trace metals added to the

system. Manganese (615 ug g^{-1}) was evenly divided among the 3 phases whilst the trace metals copper (30.0 ug g^{-1}), zinc (67.1 ug g^{-1}) and lead (11.0 ug g^{-1}) were associated primarily with the residual phase, as is expected for a non-polluted system.

THE CHEMICAL ENVIRONMENT IN SOME WETLANDS OF THE PERTH REGION

I.R. Lantzke, Western Australian College of Advanced Education

The seasonal nature of the climate produced the most significant effects on the concentrations of major ions (Na^+, K^+, Ca^{2+}, HCO_3^-, Cl^-), ortho-phosphate, dissolved oxygen, pH and water temperatures recorded at 12 lakes in the Perth region. Two patterns of anion dominance ($Cl^-|HCO_3^-$, at all times; Cl^- HCO_3^-, seasonally) and three patterns of cation dominance ($Na^+|Ca^{2+}|Mg^{2+}|K^+$; $Na^+|Mg^{2+}|Ca^{2+}|K^+$; Na^+: Ca^{2+}: Mg^{2+} varying seasonally $|K^+$ were observed.

Physical and biological factors were considered as primary determinants of the species diversity in each lake. Ionic composition, oxygen concentration, and pH are though to operate only as limiting factors.

IN BRIEF

Please note a correction to the caption for the photo of Professor Noel Hynes (Vol.23, No.3). The caption was not meant to suggest that Prof. Hynes was suffering from a disease. The Editor offers her apologies.

ROYAL MICROSCOPICAL SOCIETY - 1986

21 May	RMS AGM and Presidential Address
14-18 July	Principles of Light Microscopy Course
21-25 July	Photomicrography Course
21-25 July	Polarised Light Microscopy Course
8-12 Sept	Fluorescence Microscopy Course
8-12 Sept	Principles of Histochemistry Course
15-19 Sept	EM Cryotechniques Course
15-19 Sept	Specialised Scanning Electron Microscopy Course
16-18 Sept	3rd International Autoradiography Meeting

22-26 Sept	Electron Microscopy in Pathological Diagnosis Course
22-26 Sept	Immunocytochemistry Course
15-19 Dec	Monitoring and Maintaining the EM Course

Further details from:

The Administrator, Royal Microscopical Society,
37/38 St. Clements, Oxtord OX4 1AJ

REGULATED RIVERS: CALL FOR PAPERS

Regulated Rivers is intended to embrace all aspects of research and management in its field, including review papers, research papers and short communications. It will appear for the first time in spring 1986 and, except for a five-issue first volume, will be published quarterly. The editorial board included Dr Geoff Petts (University of Loughborough, UK) as Editor-in-Chief, and several regional editors, including myself.

In preliminary evaluations carried out by the publisher, John Wiley, the journal proposal attracted very strong encouragement from a sample of its prospective audience. I gather this is unusual in these days of proliferating journals, and a good indication of a secure niche on the library shelf!

The first years are crucial for any journal, and it is important that we gather first-class material for the early issues. It is especially important, I think, that Australian work is well-represented. I would be pleased to hear from anyone who has work in progress, or already completed, that might the suitable for this new journal.

K.F. Walker
Department of Zoology
University of Adelaide

ENVIRONMENTAL POLLUTION - An International Journal

Editors

J.P. Dempster, Monks Wood Experimental Station, Abbots Ripton, UK.

W.J. Manning, Department of Plant Pathology, University of Massachusetts, Amherst, USA.

Chairman: Kenneth Mellanby, Monks Wood Experimental Station, Abbots Ripton, UK.

Environmental Pollution Series A is concerned mainly with the biological effects of pollution, and includes research papers on the ecological effects of all types of environmental pollution and pollution control. The journal discusses the ecological implications of pollution problems from many points of view including the international, political, economic, social, medical, managerial, planning and engineering aspects.

Series B of Environmental Pollution is concerned with the chemical and physical aspects of pollution and includes research papers on the distribution of pollutants and new techniques for their study and measurement. The journal provides a vehicle for the widest dissemination of original papers discussing the ecological implications of pollution problems from many points of view including the international, political, economic, social, medical, managerial, planning and engineering aspects.

Subscription Information

Series A (ISSN: 0143 1471)
Volumes 40, 41, 42 (1986) 4 issues per volume.
Price: £225.00/US$372.00-outside UK delivery.

Series B (ISSN: 0143 148X)
Volumes 11 & 12 (1986) 4 issues per volume.
Price: £150.00/US$248.00-outside UK delivery.

Combined Subscription, Series A & B: £335.00/US$553.00 outside UK delivery.

FEDERATION OF AUSTRALIAN SCIENTIFIC AND TECHNOLOGICAL SOCIETIES

John Kirk attended the first meeting of the Federation of Australian Scientific and Technological Societies (FASTS) on 12 November 1985 on behalf of the ASL. Two levels of membership were proposed:

(1) corporate at $4.00 per head for the first 18 months
(2) associate at one tenth of the corporate fee (but no voting rights).

John registered ASL for associate membership subject to ratification by the executive. Thus ASL which has a membership of about 380 will have to pay $152. Whether ASL should upgrade its membership of FASTS to the corporate level will be discussed at the Lorne Conference.

A CANBERRA CHAPTER FOR ASL

Peter Cullen and Richard Norris (Canberra College of Advanced Education) are organising a meeting of ACT ASL and Australian Marine Sciences Association members (AMSA) with a view to holding regular meetings/seminars on topics of joint interest.

It is hoped that Keith Lewis, Director of the Department of Engineering and Water Supply SA and Chairman of the Australian Water Research Advisory Council will talk at the first meeting. WATCH THIS SPACE FOR DETAILS.

PROSPECTUS ON INTERNATIONAL LAKE ENVIRONMENT COMMITTEE

This Committee was established following the 1984 Shiga Conference on Conservation and Management of World Lake Environments held at Lake Biwa, Japan's largest lake.

The Committee has been set up to promote national management of natural and manmade lakes and their environments consistent with sustainable development policies. It is anticipated that the Committee will act as a scientific advisory body to UNEP in the implementation of the program for Environmentally Sound Management of Inland Waters (EMINWA).

The second conference, will be May 18-21 1986 on Mackinac Island in Michigan USA.

Further Information can be obtained from:
Cheryl Bartz
Michigan Department of Natural Resources
PO Box 30028
Lansing MI 48909
USA

25TH ASL CONGRESS

This meeting will be held at Erskine House, Lorne (on the Otway coast southwest of Melbourne) 10-12 May 1985. For further details contact Margaret Hart, 22 Netherby Av. Mulgrave Vic 3170.

COMING EVENTS

3-6 JUNE
Pro Aqua-Pro Vita - covers all environmental and pollution control techniques, Basle, Switzerland. Contact: Swiss Industries Fair, Pro Aqua-Pro Vita 86, PO Box, CH-4021 Basle, Switzerland.

22-26
American Water Works Association 1986 Annual Conference and Exposition, "Water-Key to Life" Denver, Colorado, USA Contact: AWWA International Affairs Committee, 6666 West Quincy Ave, Denver, Colorado 80235 USA.

22-29 JUNE
Nineteenth International Ornithological Congress. Ottawa, Canada. Details from: Dr Henri Ouellet, 19th Congressus Internationalis Ornithologicus, National Museum of Natural Sciences, Ottawa, Ontario, Canada KIA OM8.

22 JUNE - 9 JULY
Second International Symposium on Indo-Pacific Marine Biology. Venue: University of Guam. Details: Prof. D.H. Montgomery, Biological Sciences, Cal Poly State University San Luis Obispo, California, USA, 93407.

23-26 JUNE
Combined meeting of the American Society of Limnology and Oceanography and the Phycological Society of America, University of Rhode Island Narragansett, USA Contact: Dr C. Oviatt, Graduate School of Oceanography, University of Rhode Island, Narragansett Bay Campus, Narragansett Rl 02882-1197 USA.

7-11 JULY
First European SEM Congress, London Contact: The Administrator, The Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ UK.

15-16 JULY
Fifth conference on science and technology, Sydney, NSW Contact: Mr S. McKay, Secretary ANZAAS-AIST Conference, School of Biological Sciences, Macquarie University, North Ryde, NSW 2113

15-18 JULY
The behaviour of fishes University College, Bangor. Meeting jointly organised by the Fisheries Society of the British Isles and the Int. Association of Fish Ethologists. Contact: Dr J.R. Allan, School of Animal Biology, Univ. College of North Wales, Bangor, Gwynedd, LL37 ZOW.

20-24 JULY
Conference on research and applications of aquatic plants for water treatment and resource recovery, Orlando, Florida, USA Contact: Dr Wayne H. Smith, Chairman, Aquatic Plants Conference Steering Committee, University of Florida, IFAS, McCarty Hall, Room G040, Gainsville, FL32611 USA

4-6 AUGUST
International symposium on drainage basin sediment delivery, Albuquerque, New Mexico, USA. Contact: Professor R.F. Hadley, Department of Geography, University of Denver, Denver C.O. 80208 USA

10-16 AUGUST
IV International Congress of Ecology. Global connections in ecological theory and practice. SUNY, Syracuse, New York. Details from: IV International Congress of Ecology, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210, USA.

17-24 AUGUST
The First International Congress of Dipterology. Venue: Budapest, Hungary. Details: Dr. Laszlo Papp, Zoological Department, Hungarian Natural History Museum, Baross u. 13., Budapest, H-1088 HUNGARY.

24-29 AUGUST
Fourth International Symposium on Microbial Ecology, Ljubljana, Yugoslavia. Contact: Prof. France Megusar, Biotechnical Faculty, E. Kardej University of Ljubljana, Jamnikdrjeva 101, 61000 Ljubljana, Yugoslavia.

25-28 AUGUST
The ecology of the Australian wet tropics - Ecological Society of Australia and Australian Systematic Botany Society symposium, Brisbane, Qld Contact: Uniquest Limited, University of Queensland, St Lucia, Qld 4067

25-29 AUGUST
Third European Congress of Entomology. Netherlands Entomological Society, Amsterdam.

15-19 SEPTEMBER
Seventh international symposium on aquatic weeds: The biology and control of aquatic weeds, Loughborough, Leicestershire, UK. Organised by the European Weed Research Society and the Association of Applied Biologists. Contact: Dr Max Wade, Department of Human Sciences, Loughborough University of Technology, Loughborough, Leicestershire, LE11 3 TU, UK.

25-27 NOVEMBER
Hydrology and water resources symposium 1986 "River Basin Management" Brisbane Qld Contact: The Conference Manager, Hydrology and Water Resources Symposium 1986, The Institution of Engineers, Australia, 11 National Circuit, Barton ACT 2600

1987

26-30 JANUARY
Fifty sixth Australian and New Zealand Association for the Advancement of Science Congress, Palmerston, New Zealand. Contact: Dr M. Baxter 56th ANZAAS Congress PO Box 5158 Palmerston North, N2.

8-14 FEBRUARY
Twenty third SIL Congress, Hamilton, New Zealand, Contact: Convention Management Services, PO Box 3839, Auckland, New Zealand

16-20 FEBRUARY
Fourth International Symposium on the Interaction between Sediments and Water, Melbourne. Contact: ACTS GPO Box 1929 Canberra ACT 2601.

18-24 FEBRUARY
Fifth international conference on Ephemeroptera, Marysville, Victoria. Contact: Dr I. Campbell, Water Studies Centre, Chisholm Institute of Technology, East Caulfield, Victoria 3145.

18-24 FEBRUARY
Ninth international conference on Plecoptera, Marysville, Victoria. Contact: Dr I. Campbell, Water Studies Centre, Chisholm Institute of Technology, East Caulfield, Victoria 3145.

25-29 MAY
Biology in Water Management, Academic Committee of the Hungarian Academy of Sciences, Veszprem, Tolbuchin U 37 Hungary. Contact: Secretariate, Budapest VI., Rozsa F.u. 91. H-1064, Hungary.

15-20 JUNE
International Conference on Reservoir Limnology and Water Quality, Ceske Budejovice, Czechoslovakia. Contact: Dr M. Straskraba, Hydrobiological Laboratory, Inst Landscape Ecology, Czeckoslovak Academy of Science, Na Sadkach 7, 370 05 Ceske Budejovice, Czecholslovakia.

24 JULY - 1 AUGUST
XIVth International Botanical Congress, Berlin, FRG. Contact: XIVth International Botanical Congress, Botanisches Museum Berlin-Dahlem, Konigin - Luise - Strasse 6-8, D-1000 Berlin 33, FRG.

1988

AUGUST 29 - SEPTEMBER 2

First Biennial Water Quality Symposium, Banff Centre, Banff, Alberta, Canada. Contact: B.J. Dutka and D.L. Liu, Co-Chairmen Water Quality Symposia Committee, NWRI CCIW PO Box 5050 Burlington, Ontario, Canada L7R 4A6.

LIMNOLOGY BIBLIOGRAPHY

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PALAEOLIMNOLOGY EXCURSION - 12 MAY 1986

Patrick De Deckker is planning to organize a post-congress excursion in the Colac-Camperdown area of Victoria. The theme of the excursion is palaeolimnology, principally of mar lakes (Keilambete, Terang, Bullenmerri, Gnotuk etc...).

The excursion will be done using private cars, although it could be arranged for participants without a car to be given a "lift", and for them to be dropped later on at a railway station along the Warrnambool-Melbourne line. People wanting to participate in the excursion should inform Patrick De Deckker of their intention (by filling in the form below) so sufficient excursion pamphlets could be printed and for the organization of a nice lunch, perhaps at the Purrumbete Homestead.

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12 May 1986 - PALAEOLIMNOLOGY EXCURSION

I intend to participate in the excursion:

Name:

Address:

Tel:

I require a lift _____

I can offer a lift _____ and have _____ seats available.

Return to: Dr P. De Deckker
Department of Geography
Monash University
CLAYTON, Vic, 3168
Telephone (03) 541-2122